human food chain. Plants are capable of translocating trace elements and concentrating them in plant tissues. Accumulated in the edible portion of the plants, they would pose a threat to consumers.

Experimental results from solution culture and greenhouse potted plants indicate that plant uptake usually increases with increased trace-element concentration in the growing medium. In some plant species, even at sub-phytotoxic concentrations, the accumulation in the plant tissue could become significant.

Data from an on-going sludge disposal experiment show the increased concentrations of certain trace elements in the tissue of a sensitive plant grown under field conditions (table 4). Under the same conditions, no increases in trace elements were found in barley, which is a non-sensitive plant.

Continuing experimentation is needed to project the long-range effects. It appears that the potential accumulation of trace elements in plant tissue can be minimized by proper selection of crop species, soil types, and sludge compositions. For sludges that are unusually high in trace elements, however, land disposal definitely would be detrimental to plant growth and the human food chain.

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Water quality requirements for floricultural operations

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Compared to most food crops, floricultural and ornamental greenhouse crops use large amounts of irrigation water per square foot of production area. This is because of shallow soils in containers and raised beds and because of high leaching requirements when nutrient solutions are added. As a result of the large amounts of water generally being leached and its high nutrient content when fertilizers are injected into the irrigation stream, there is increasing pressure to (1) conserve water in greenhouse operations and (2) avoid contamination of surface- and ground-water supplies by reusing nutrient solutions and runoff water that might otherwise move off the premises.

This growing need for recycling adds to the water quality problems faced by greenhouse operators. Unlike other types of agriculture, greenhouse production must be concerned with water quality not only because of its effect on the crop, but also because additional standards must be met for the water used in mist propagation, in greenhouse cooling, and in conditioning cut flowers before shipment.

The water quality standards listed as presenting "no problem" in the U.C. Guidelines for Interpretation of Water Quality for Agriculture generally apply to ornamental greenhouse crops also. Salinity less than 0.75 millimhos per centimeter, adjusted Sodium Absorption Ratio (SAR) less than 3, and chlorides less than 3 milliequivalents per liter (meq/l) (106 ppm) should be satisfactory for almost all crops, if drainage is good. Crop tolerances for dissolved salts vary widely: Chrysanthemums make satisfactory growth at electrical conductivity (EC) from 1.5 to 2.5, but certain azalea cultivars may show reduced growth or damage symptoms at EC 0.75.

In mist propagation, experience indicates that foliar problems probably can be avoided when both chloride and sodium concentrations are less than 3 meq/l. Carbonates and bicarbonates at more than 100 ppm (1.66 meq/l) can result in both foliar deposits and clogging of mist nozzle orifices. However, carbonates do not form unless the pH of the water is higher than 8.3, and acidification with phosphoric or sulfuric acid can solve the problem. A final pH of 6.5 is generally satisfactory.

Most greenhouses are cooled with evaporative fan and pad systems, which require passage of water over permeable fiber or cell pads from which the water is evaporated. The resulting concentration of salts eventually clogs the pads. Soluble salts like chlorides and sodium can be dissolved with high-pressure streams of water and washed away. Deposits from high-carbonate water will not respond to this treatment, and acidification of the cooling water may be necessary. To avoid concentration of salts in the recycled cooling water, "bleeding off" 10 to 20 percent of the returned water and replacing the water level in the sump with fresh water is a generally accepted and highly desirable practice.

Cut flowers are normally conditioned or "hardened" by placing the stems in water for a period before packing or shipping. Recent University of California experiments indicate that even small amounts of dissolved salts in the water used for conditioning can adversely affect the keeping quality or shelf life of the flowers. The effect becomes even more pronounced when chemicals or so-called flower preservatives are added to the water. In a number of experiments the shelf life of carnations and chrysanthemums was extended from .5 to 2.5 days when deionized water was used instead of tap water with an EC of 0.5 to 0.75. Because of the small amounts of water used in conditioning and because the conditioning solutions can be reused for some time, it is recommended that both growers and handlers of flowers install deionizing equipment.

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Dramatic differences in carnations seven days after harvest as a result of conditioning the cut blooms in deionized water. Blooms were conditioned in: left, deionized water; middle, a mixture of three-fourths tap water and one-fourth deionized water; right, undiluted tap water.